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THE

MECHANICAL

MINERS' GUIDE,

ISSUED BY

A. S. HALLIDIE,

Wire and Wire Rope Works,

OFFICE AND DEPOT:

Nos. 113 and 115 PINE STREET,

SAN FRANCISCO, CAL.

1873.

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C. A. MURDOCK & CO., BOOK AND JOB PRINTERS,
No. 532 Clay Street.

A. S. HALLIDIE,

MANUFACTURER OF

IRON AND STEEL WIRE ROPES,

OF ALL KINDS AND SIZES FOR

Mining, Shipping and General Purposes,

ESTABLISHED, 1857.

Office and Depot: 113 and 115 Pine Street,

SAN FRANCISCO.

Sole Proprietor of the Patent Endless Ropeway, for Transporting Material over Difficult Roads, secured by numerous U S. Patents.

Patent Grip Pulley for Transmitting Power.

Wire Suspension Bridge Work.

Agency of Messrs. Richard Johnson and Nephew, Wire Manufacturers, Galvanizers and Dealers in Iron.

Metals Imported on Favorable Terms.

Agency of the Pacific Wire Manufacturing Company, of California.

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IRON AND STEEL WIRE ROPE WORKS,

SAN FRANCISCO, CAL.

1873.

I am prepared to furnish the Mining, Manufacturing, Shipping and Ferry Interests on the Pacific Coast, with Iron and Steel Wire Rope of all kinds, in any length, size and quantity desired, from my manufactory in San Francisco, on favorable terms. A. S. HALLIDIE.

Wire Rope is now generally employed for Mining, Ferry, Shipping and general purposes; and forty years' experience has proved that it possesses many great advantages over Hempen Ropes—being lighter, stronger, more durable and cheaper than Hemp or Manila, and is not affected by atmospheric changes.

The many purposes to which Wire Rope has been applied where Hemp Rope would soon have been destroyed, and Chain found too heavy, soon induced its general adoption throughout the mining regions of the civilized world; wherever shafts and incline planes are sunk to great depths and the universal preference given to it over other ropes and chain, is a sufficient guarantee of its superiority. In California, the consumption of rope for mining purposes is enormous. Until the erection of my Works, Wire Rope was not in the market, although the requirements of the mining and shipping interests had long since demanded it. This demand I am now able to supply, having, during the past year, erected entirely new works, with machinery of the most approved pattern, capable of turning out all kinds of Flat and Round Wire Rope which is

guaranteed to be equal to any made. The Wire Rope Works being under the immediate superintendence of an experienced Wire Rope maker, many years superintendent of one of the largest Wire Rope works in Great Britain. I am enabled to manufacture an article suitable for this market, in every respect.

Two kinds of Wire Rope are made, Coarse Rope having 42 wires and Flexible Rope having 114 wires. The latter being used for hoisting, etc., when the sheaves or drums are of small diameter.

It is almost impossible to specify the precise uses to which Wire Rope is adapted in preference to hempen ropes or chain; but for the following purposes it has been a long time in use, and in every respect is much preferred:

For Hoisting from Deep Shafts and Incline Planes.
For Guy Ropes for Derricks.
For Pump Ropes for driving River Machinery.
For Suspension Cables for Water Conduits or Aqueducts.
For Signal Cord.
For Ferry Ropes.
For Ships' Standing Rigging.
For Tiller Ropes for Steamers.
For Guy Ropes for Smoke Stacks.
For Sash Cord for Window Sashes, Hanging Pictures, etc.
For Power Ropes, for conveying power to any distance.
For Wire Tramways.
For Endless Wire Ropeway, for the transportation of material over mountainous and difficult roads, etc.
For Steam Cultivation and Land Tillage.

General Remarks on Wire Rope.

The numerous purposes to which rope is applied, its great cost being a large item in a mining company's expenses, necessitates the use of economy in its application; therefore, when it is satisfactorily proved, that by the application of Wire instead of Hemp Ropes, a saving can be effected, it should be a guarantee of its general adoption.

When the machinery is properly arranged, and drums and pulleys properly proportioned, the durability of Wire Rope over the best quality of Hempen Ropes, is as 3 to 1. But Wire Rope can be destroyed, like other rope, if badly used; and as we do not claim for Wire Rope more than it deserves, the surest test is a fair trial; but we do claim for it the following advantages over other ropes, under a fair and legitimate trial:

1st—It is less than two-thirds the weight of a dry Hemp Rope.

2d—It is but one-fourth the weight of a wet Hemp Rope.

3d—It is less than one-half the size for same strength.

4th It does not stretch and shrink, (being unaffected by the atmosphere,) nor does it absorb moisture.

5th—It is three to five times as durable.

6th—The excessive heat of the Summer sun does not rot it, nor does the moisture of Winter cause it to swell.

7th—It can be spliced as easily, wet or dry—frozen or otherwise—and more snugly and neatly than Hemp Rope.

8th—And lastly—We do not have to send to Manila or Russia, or any other foreign country, for the raw material, but obtain it from the iron-fields of our own country, thus being essentially a home-manufactured article.

Explanation of the Signs used in this Work.

Addition or plus, . . $+$	Division, . . $\div$	Cube Root, $\sqrt[3]{}$
Subtraction or minus, $-$	Equal to, . $=$	Square, . . ^{2}
Multiplication, . . . $\times$	Square Root. $\sqrt{}$	Cube, . . . ^{3}

On the Power of Blocks and Tackles.

RULE FOR ASCERTAINING THE POWER TO BE EXERTED IN RAISING WEIGHTS BY PULLEYS.

When only one Rope or Cord is used.

RULE—Divide the weight to be raised by the number of the parts of the rope engaged in supporting the lower or moveable block..

Ex. 1. What power is required to raise 1200 lbs. when the lower block contains six sheaves, and the end of the rope is fastened to the upper block?

1200lbs. $\div$ 12 $=$ 100lbs., the power to be exerted.

Ex. 2. Suppose the end of the rope is fastened to the lower blocks, what power is required?

1200. $\div$ 13 $=$ 92 4-13 lbs., the power to be exerted.

TO ASCERTAIN WHAT WEIGHT CAN BE RAISED BY CERTAIN POWER EXERTED.

RULE – Multiply the number of the parts of the rope by the power exerted:

Example. Suppose six parts of rope to be used and fifty pounds power exerted—the weight that can be raised will be 300 lbs.

Note—The Doyle Chain Pulley consists of a double and single block, the upper block consisting of two chain sheaves, of different diameters, fixed to each other—the lower block being a single chain sheave. The power gained being in proportion to the difference in the diameters of the two upper sheaves—the smaller the difference the greater the power, and vice versa. The chain fall is endless and does not run back by the load being hoisted.

Galvanized Iron Wire Rope for Ships' Standing Rigging.

Possesses many advantages over Hemp, requiring no stripping or refitting, as Hemp Rope must have every few years; and being once set up, it obviates the attention and trouble caused by the stretching and shrinking of Hemp, and by its extreme lightness, being but two-thirds the weight of Hemp, increases the ship's capacity for cargo. And the advantage derived from the smaller surface opposed to the wind, (Wire Rope being one-half the size of Hemp,) especially in beating to windward, needs no comment—while for the jib and flying-jib stays, its smallness and smoothness permit the hanks to travel on it much more freely.

The following are some of the advantages of Wire Rope:

1. Wire Rope is not affected by atmospheric changes, consequently does not stretch and shrink in dry or wet weather, avoiding the necessity of repeated setting up as in Hemp.
2. Wire Rope is 40 per cent. less weight than Hemp, saving so much top hamper.
3. Wire Rope is very much smaller for equal strength, and having but four-tenths the surface of Hemp Rope exposed to the wind, enables the ship to run closer to the wind.
4. Wire Rope is spliced equally well in all kinds of weather, and much more neatly than Hemp.
5. The jib runs down Wire Rope freer, seldom requiring the down haul.
6. Wire Rope presents a neat and trim appearance, looks ship-shape; and one suit of wire rigging in the absence of accident, will last the ship's life.
7. Lastly, and to ship owners very important! Wire Rope COSTS VERY MUCH LESS than Hemp or Chain.

Extract from the Report of the Secretary of the Navy, 1867.

"During the year twenty-three vessels have been wholly, and several others partially, wire rigged. Tests of the comparative strength of Wire and Hemp Rope, and reports of commanders of wire rigged vessels have been so satisfactory, that the Bureau recommend the erection of a building, and the purchase of necessary machinery for the manufacture of wire rigging," (at Charlestown Navy Yard).

Extract from San Francisco "Times," August, 1867, in reference to the burning of the ship "Blackwall" in this harbor.

"The forehold, where the fire originated, was burned nearly down to the shell—the forecastle was completely destroyed, the foremast so badly burned that it will have to be taken out, and the houses on deck were also rendered useless. *It was a fortunate thing that the ship's rigging was all wire; had she been rigged with Hemp the shrouds would, of course, have caught fire*, and the masts and yards would in all probability have been burned, and the difficulty of saving her would have been doubled."

Wire Rope possesses so many advantages for the standing rigging of ships that it is rapidly displacing every other kind of rigging.

Tiller Ropes.

As a Tiller Rope for river steamers, it is superior to chain, being lighter, cheaper, and more easily managed, the objection caused by the links of the slack chain catching in the rollers—thus endangering the safety of the boat—is entirely removed.

Moreover, in case of a fire on board, it is free from danger, while a Hemp or Raw Hide Rope, running as it does from one end of the boat to the other, is the first thing to become destroyed. With a Wire Rope, the pilot can stick to the helm as long as the fire will permit him.

Wire Cord,

FOR HANGING SASHES, PICTURES, DUMB WAITERS, CLOCK-WEIGHTS, AND FOR SIGNAL CORD.

This Cord is made from iron, steel and copper wire, is very light, durable and pliable, aud is not subject to rot. It has been in nse for many years for the purpose of hauging window sashes, being much preferred to any other cord. No house should be without it. (See List of Prices, on last page.)

Lightning Conductors.

Copper Wire Rope Lightning Conductors are much in use among the shipping, as a protection against the effects of lightning on a ship's mast. They are superior to any other conductor as a protection against lightning for church spires, tall chimueys, etc., are much more easily fixed, and do not get ont of order. (See List of Prices, ou last page.)

Wire.

Iron, Steel, Copper and Brass Wire, of all sizes and kinds, constantly on hand and supplied to dealers on favorable terms. Also, Baling and Suspeusion Bridge Wire. (See last page.)

Tensile Strength of Materials.

Weight or force necessary to tear asunder 1 in. square in lbs.

Metals.

Copper..........lbs.	32,500	Lead, cast......lbs.	1,800
Copper Wire..... "	61,200	" milled.... "	3,320
Gold, cast....... "	20,000	Platinum Wire.. "	53,000
Iron, cast, lbs., 18,000 to	30,000	Silver, cast...... "	40,000
" medium bar, lbs.	50,000	Steel, soft....... "	120,000
Iron Wire....... "	103,000	" razor..... "	150,000

Woods.

Ash.............lbs.	16,000	Mahogany......lbs.	21,000
Beech........... "	11,500	Oak, Amer. white "	11,500
Cedar........... "	11,400	Oak, seasoned... "	13,600
Elm............. "	13,400	Pine, "pitch,".. "	12,000
Fir, strongest.... "	12,000	Teak, Java...... "	14,000
Lignum Vitæ.... "	11,800	Walnut......... "	7,800

Miscellaneous Articles.

Brick...........lbs.	290	Slate...........lbs.	12,000
Ivory............ "	16,000	Whalebone...... "	7,600

Note—The practical value of the above is about one-fourth.

TO FIND THE STRENGTH OF DIRECT COHESION.

RULE.—Multiply area of transverse section in inches by weight given in the preceding table—the product is the strength in lbs.

Example.—What is the strength of a bar of medium iron 2 inches square?

Transverse section of 2 inches=4 inches, multiplied by 50,000, equals 200,000 lbs., the answer required.

The absolute strength of materials pulled lengthwise, is in proportion to the square of their diameters.

Iron and Steel Wire Rope for Hoisting.

From Deep Shafts, Incline Planes or Slopes, it is particularly well adapted, being so much lighter than other ropes or chain, requires proportionately less power to hoist it, and occupies less than half the space on the drum. Its durability is from three to five times that of Hemp or Manila, and its weight is not increased or its fibres destroyed by working in wet situations.

As a practical illustration of the advantages of Iron Wire Rope over Hempen Rope, we submit the following:

Shaft 500 feet, Load including Cage...............	3,000 lbs.
500 feet, 2 in. diameter, dry Hemp Rope weighs...	650 lbs.
500 feet, $\frac{3}{4}$ in. diameter, Iron Wire Rope.........	420 lbs.
Difference in favor of Wire Rope.............	230 lbs.

Allowing 1 minute hoisting time, then $\frac{500}{1} \times \frac{230}{2} = 57,500$ ft. lbs. $= 1\frac{3}{4}$ horse-power saved by using Iron Wire Rope.

The difference in favor of Steel Wire Rope is still greater, and may be summed up as follows:

1st. Steel Wire Rope is three times as durable as the best Manila or Hemp Rope.

2d. Steel Wire Rope weighs only four-tenths the weight of Manila of equal strength, when dry, and one-fourth when Manila or Hemp is wet.

3d. Steel Wire Rope is only one-third the thickness of Manila of equal strength

4th. Steel Wire Rope possesses more springiness or elasticity than any other kind of rope.

5th. The first cost of Round Steel Wire Rope is 75 per cent. the first cost of Manila Rope.

From the above, we invite Superintendents and Engineers of Mining Companies using rope, especially in deep shafts, to the following analysis of comparative cost, etc.

1st. Round Steel Wire Rope has been employed in California, for over five years, in vicinities of Grass Valley, Downieville and Columbia, and the durability usually exceeds four times that of Manila.

2d. Take, for instauce, a Manila Rope 2¼ inches thick, 1,000 feet of this size rope will weigh about 2,200 ℔s., *when dry.* Ronnd Steel Wire Rope, same strength and length, will weigh 900 ℔s., *wet or dry.* Differeuce in favor of Steel Rope, 1,300 ℔s. For a 1,000-foot hoist, allowing two minutes, $\frac{1000}{2} \times \frac{1300}{2} = 325{,}000$ ft. ℔s. = 10-horse-power; using say ½ cord wood at $6 per cord = $3 per day or $1,080 per anuum, (360 days,) expended iu *hoisting up a dead weight of Manila Rope*, over *that of Steel Rope.* Add to this the straiu, wear and tear of the machiuery, and you will ascertain approximately what the preseut outlay is for hoisting ropes.

3d. The thickuess of Round Steel Wire Rope being one-third that of Manila of equal strength, it takes proportionately less room on the winding drum; thus 1,000 ft. Steel Rope, ¾ in. diameter, will wind on a drum five feet diameter and four feet long, with a *single* layer, while it will require *three layers* of Manila.

4th. Steel Wire Rope, although possessing more springiness in itself, does not *stretch out* like Manila, but takes back the spriug it has given out. This elasticity relieves the dead strain ou the rope, especially in case of sudden start of the hoisting engine.

SUMMARY:

Life of Manila Rope, say 4 months, equal 3 ropes for 1 year, each rope costs, say $400..............	$1,200
Extra cost of fuel for hoisting dead weight, 1 year..	1,080
Cost of 1 year runniug of Manila Rope............	$2,280
1 Round Steel Wire Rope equal to above 1 year....	400
Annual saving effected by using Steel Wire Rope	$1,880

We submit the above facts for your consideration and verification, modifying it to suit localities.

In applying Round Steel Wire Rope the *groove* of the pulley over which the rope runs should be of the *same form and size* as the rope employed, aud all drums aud pulley sheaves should be 100 times the size of the rope,

The Transverse Strength of Materials.

The transverse strength of any beam or bar of wood or metal is as the sqnare of the depth multiplied by the hreadth and divided by the length hetween the supports.

The transverse strength of any square beam of equal length, is as the cube of their depth—and that of cylindrical beams as the cube of their diameter.

The strength of a projecting heam is only one-fourth of what it would be if supported at both ends, and the weight applied in the middle.

The strength of a projecting beam is only one-sixth of what it would be if *fixed* at both ends, and the weight applied to the middle.

The strength of a beam to support a weight in the centre of it when the ends rest merely npon two snpports, compared to one the ends being fixed, is as 2 to 3.

Table of the Transverse Strength of American Timber.

"Seasoned."	Breaking W'ght in lbs.	Greatest deflection.	Weight borne with safety	Value for general use.
White Oak......	240	9 in.	196 lbs.	30
Yellow Pine	150	1.7 "	100	30
White Pine.....	135	1.4 "	95	32
Ash	175	2.4 "	105	25
Hickory	270	8 "	200	32

Each of the above was 1 foot long and 1 inch square *with weight suspended from one end.*

Cylinder 1 foot long.

	Breaking W'ght in lbs.	W'ght borne with safety.	Value for general use.
White Pine, 2 in. diam.	610	460	20
White Pine, 1 in. diam.	75	56	20

Transverse Strength—Continued.

Table of the Transverse Strength of Cast and Wrought American Iron, weight suspended from one end.

Cylinder 1 foot long and 3 iuches diameter.

	Breaking w'ght in lbs.	W'ght borne with safety.	Value for general use.
Cast Iron, cold blast......	12,000	8,000	300

Square Bar 1 foot long by 2 iuches.

	Breaking w'ght in lbs.	W'ght borne with safety,	Value for general use,
Cast Iron, cold blast......	5,781	4,000	450

Square Bar 1 foot long by 1 inch.

	W'ght borne with safety,	Deflection from horizontal plane without rupture.	W'ght that gave a permanent bend,	Deflection in inches with last weight,	Value for general use,
Wrought Iron	1,520 lbs.	53°	600	1	300

The values above given are for good iron. If inferior iron is nsed, a correspondiug deduction should be made.

RULE TO FIND THE TRANSVERSE STRENGTH WHEN A RECTANGULAR BAR OR BEAM IS FIXED ON ONE END AND LOADED AT THE OTHER:

Multiply the *value* in the precediug table by the breadth and square of the depth in inches, and divide the prodnct by the length in feet. The quotient is the weight in lbs.

N. B. When the beam is uniformly loaded throughout its length, double the result.

Example.—What weight will a 2 in. square wrought iron bar bear, projecting 2 ft. 6 in. in length?

Value for wrought iron, $300 \times 2 \times 2^2 = 2400 \div 2\frac{1}{2} = 960$ lbs. Answer required.

Transverse Strength—CONTINUED.

WHEN THE BEAM IS FIXED AT BOTH ENDS AND LOADED IN THE MIDDLE:

RULE. Multiply the *value* in the preceding table by six times the breadth, and the square of the depth in inches, and divide by length in feet. The result must be doubled when the weight is evenly distributed along its length.

Example.—What weight will a bar of cast iron 2 in. square and 5 feet in length support in the middle, when *fixed* at the ends?

Value for cast iron, $450 \times (6 \times 2 \times 2^2 =) 48 = 21600 \div 5 = 4320$ lbs., answer.

WHEN THE BAR OR BEAM IS SUPPORTED AT BOTH ENDS AND LOADED IN THE MIDDLE:

RULE. Multiply the *value* in the preceding table by the square of the depth, and four times the breadth in inches, and divide the result by the length in feet.

Note.—When the weight is uniformly distributed, double the result.

Example 1. What is the weight a cast iron bar 5 feet between the supports and 2 inches square, will support?

Value for cast iron, $450 \times 2^2 = 1800 \times (2 \times 4)\ 8 = 14400 \div 5 =$ 2880 lbs., answer.

Example 2. What is the weight a white pine beam, 10 feet between supports, and 8 inches deep by 4 inches in breadth, will bear?

Value for white pine, $32 \times 8^2 = 2048 \times (4 \times 4 =) 16 = 32768 \div 10$ $= 3276\ 8\text{-}10$ lbs., answer required.

Transverse Strength—Continued.

TO FIND THE DIAMETER OF A SOLID CYLINDER TO SUPPORT A GIVEN WEIGHT IN THE MIDDLE BETWEEN THE SUPPORTS:

Rule.—Multiply the weight in pounds by the length in feet, divide by the value, and the cube root of ¼ of the quotient is the diameter in inches.

Example 1. What is the diameter of a cast iron cylinder 8 inches long between the supports, that will support 60,000 lbs. suspended in the middle?

$60{,}000 \times \frac{8}{12} = 40{,}000 \div 300$ (value for cast iron cylinder) $= 133\frac{1}{3} \div 4 = 33\frac{1}{3}$, cube root of which is 3 1-5 inches, answer.

Example 2. What is the diameter of a white pine cylinder 2 feet long, to support same weight?

$60{,}000 \times 2 = 120{,}000 \div 20$ (value) $= 6000 \div 4 = 1500$, the cube root of which is $24\frac{3}{4}$ inches, answer.

Oak, in seasoning, loses at least one-third of its weight, and this process is facilitated by steaming or boiling.

By steaming, the specific gravity of a piece of Oak is reduced from....................................1050 to 744

By boiling, from..............................1084 to 788

By exposure to the air, from..................1080 to 928

Stiffness of Oak to Cast Iron, is as...............1 to 13

Strength " " " " ....1 to $4\frac{1}{2}$

Wood is from 7 to 20 times stronger transversely than longitudinally.

WIRE ROPE AS A SUSPENDED CARRIAGE WAY

FOR DELIVERING ROCK, LUMBER, ETC., OVER OTHERWISE INACCESSIBLE POINTS.

There are many points in the mountains where it is impracticable to build a roadway, railway track, or schute. In such a place, a practical and economical method of delivering material is to extend a Wire Rope from the upper to the lower points, when it is not too long for a single span, stretching it sufficiently tight to clear all points and obstructions, and on this Wire Rope to run a pulley, below which hangs a basket or box containing the rock—or, if it is lumber, a pulley at each end of the lumber is necessary. In many cases in sending down rock, etc., it is found better to use three pulleys, two above and one below the rope, one of the upper pulleys being in advance and the other behind the lower one. By this means the pulleys are kept in the same direction as the rope.

The pulley should be of a large diameter, the groove to be of the same size as the rope.

The Endless Wire Ropeway system is adapted for delivering material across and over mountainous and difficult roads. (See page 31.)

Wire Cables for Suspension Flumes or Water Conduits,

For conveying water across deep gulleys, cañons, rivers, etc., with galvanized iron piping, joints, suspension rods, etc., etc., complete—the most economical way of carrying water over a deep cañon, etc. Guaranteed to keep in perfect order. Estimates given, and materials furnished low.

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Wire Rope for Suspending Hydraulic Hose or Pipe Clear of a Cave.

The high banks down which a hydraulic hose descends are very apt to cave and destroy the hose. In order to insure its safety, a Wire Rope is stretched from the top of the bank to the bottom of the claim, at a sufficient angle to escape the bank in case of a cave. To this Wire Rope the hose is attached, and in such a position as to be perfectly secure from any danger of destruction by the caving of the bank.

The loss of one hydraulic hose would buy many Wire Ropes.

Wire Strand for Fencing.

Made in half-mile lengths, coiled on reels, ready for stretchiug. Fences are put up very expeditiously by placing the reels (as many as there are rails) in a wagon in such a manner as to allow the strand to "pay out" behind, while the wagon is hauled along the line of the proposed fence; the strand is then lifted from the ground and secured to the posts by staples. By this means a few men can fence in an immense amount of land in a very short time. Strand being free from kinks, aud requiriug no splicing or joining, can be put up much neater aud more expeditiously than a single thick wire.

A Wire Strand Fence, properly put up, will last a life time, and when put up, it requires no further work.

By running a narrow strip of board along the top rail, any objection to wire fence (wire strand is not open to this objection as much as a single wire) on account of wild cattle not seeing it, can be easily obviated.

Galvanized Wire Strand needs no painting, it being free from rust, etc.

Wire for Fencing. All kinds of wire on hand either galvanized or not.

[For list of prices, see last page.]

Iron and Steel Ferry Rope.

Stretched across the river, being lighter, is more easily set up, and being perfectly round and smaller, it allows the pulley blocks to run much freer and more rapidly over the rope, and removes the sudden strain caused by checking (as with a Hemp Rope) when the boat is in the centre of the stream, and does not require the constant attention of the ferryman to set up or slack off the rope according to the state of the weather; and as the sun does not rot it, it can be kept stretched during the summer Iron sheaves should in *no case* be used on Wire Ferry Rope, *unless the groove of sheave* properly fits the rope.

For a Swinging Ferry, where the rope lays in the water, it does not rot—nor does it, like Hemp, absorb the water until it becomes water-logged and clumsy. Hemp Rope, thus saturated, will have *four times* the weight of Wire Rope placed in the same position: thus in slack water, with Wire Rope there is no useless expenditure of the force of the current in carrying the rope across; and consequently, smaller and lighter buoys are required.

N. B.—We have had Wire Ropes working as above for seven years.

Ferry Blocks furnished complete.

Steel Wire Rope for Derrick Fall Ropes

Works to great advantage, especially if the hoisting is done by water or steam-power. The sheaves are made of cast iron 10 to 14 inches diameter, the groove of which conforms to the size of the rope—for ordinary work, a Steel Rope $\frac{1}{4}$ inch thick is sufficient for the purpose. A Fall of this kind properly put on, will outlast five or six Manila Falls, and occupy one-sixth the space on the drum.

Wire Rope for "Derrick Guys."

The universal adoption of the Derrick for working deep claims in the river bars, etc., in preference to any other method, being much cheaper and more expeditious, has drawn attention to its erection, and to the necessity of keeping the derrick *mast* in its proper position. With Manila Guy Ropes this is impossible. The constant stretching and shrinking of Hempen Ropes require the almost constant slacking and tightening of them, according to the state of the atmosphere; and when the mast leans out of its position, it is almost impossible to swing the boom to its proper point..

Wire Rope being unaffected by the weather, this trouble and expense is saved; being 40 per cent. lighter, it is much more easily and more tightly set up; and as the sun does not rot and destroy its fibres by its being exposed to the summer heat, it will last an incredibly long time.

Wire Rope for River Mining.

For Pump Ropes, especially if of a great length, the advantage of using Wire Rope is obvious. A Grip Pulley, see page 25, is fixed to the shaft of the water wheel and pump, a Wire Rope is used to transmit the power. See page 29. The fact that when spliced and put on the grip pulleys, the Wire Rope does not stretch and allow the pump to stop working, is a matter of very great moment to the river miner, saving him an immense amount of trouble and care; and those who have once experienced the loss of time and money by the filling up with water of a large and deep pit, can more fully appreciate this.

Measure of Rock, Earth, Etc.

25 cubic feet of sand = 1 ton.

18 cubic feet of earth = 1 ton.

17 cubic feet of clay = 1 ton.

13 cubic feet of quartz, unbroken in lode, = 1 ton.

18 cubic feet of gravel or earth, before digging, = 27 cubic feet when dug.

20 cubic feet of quartz broken (of ordinary fineness coming from the lode), = 1 ton contract measurement.

Weight of a Cubic foot of different material.

	lbs.		lbs.
Water	62¼	Lead	709
Sand	112¼	Silver (pure cast)	655
Clay	124	Gold (pure cast)	1203
Gravel (wet)	145	Quicksilver	848
Quartz	166	*Woods.*	
Loose Earth	106	Ash	48
Compact Earth	125	Beech	44
Salt (common)	133	Elm	35
Metals.		Fir	40
Cast Iron	450	Lignum Vitæ	83
Wrought Iron	480	Live Oak	70
Steel	490	Oak	56
Copper	550	Pitch Pine	41

Velocity of Streams and Resistance of Soils.

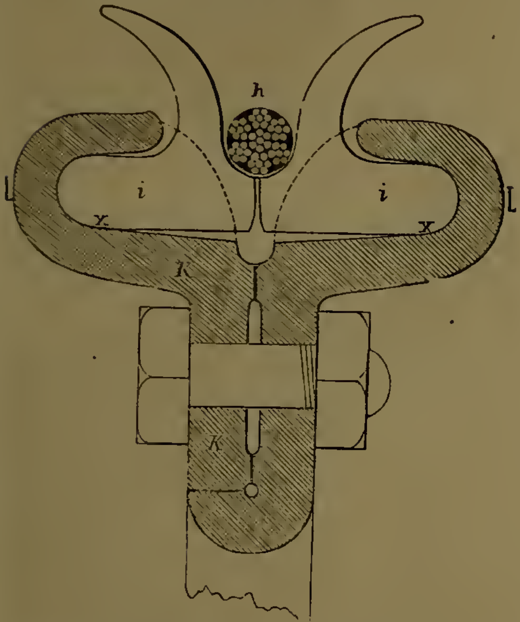
Ordinary nature of current.	Velocity In Feet per Sec.	Velocity In Miles per Hour.	Materials that resist these velocities and yield to more powerful ones.
Very Slow	0.25	0.171	Wet Ground—Mud.
Gliding	0.50	0.341	Soft Clay.
Gentle	1.00	0.682	Sand.
Regular	2.00	1,364	Gravel.
Ordinary velocity	3.00	2.046	Stony.
Rapid Floods	3.35	2.284	Broken Stones, Flints, etc.
Rapid Floods, (extraordinary)	350	2.380	Collected Boulders, soft Schistose.
Torrents and Catar'cts	9.86	6.723	Hardened Rock.

TRANSMISSION OF POWER BY WIRE ROPES.

Wire Rope is employed extensively for conveying power from one point to another, as in the case of a mill situated half a mile or so from the water-wheel from which power is obtained, and has been found to be very economical and durable. In France and Germany, Wire Rope is used wherever an economical motive power exists and can be attached, in many cases there being 5 or 6 miles between the motive power and the machinery to be set in motion. Considerable attention is now paid to this method of transmission, and the economy and simplicity of its application are very strong recommendations in its favor. The manufacture of flexible ropes from steel wire, having great strength, with lightness and elasticity, insures the extensive application of this system. Evidently the power which can be transmitted by this plan, under given conditions, depends upon the adhesion existing between the rope and the pulley, and the amount of this adhesion determines the velocity of motion of the rope, in order to transmit any given power. When, by a peculiar construction of the pulley, the adhesion is made equal, or nearly so, to the strength of the rope, the velocity of the rope can be made to be quite slow, while at the same time transmitting great power. For this purposes, the rims of the pulleys are made up of a great number of *clips* operating on the principle of the toggle joint, to clamp the rope firmly between them while they are drawn down together by the force of the strain that is put upon the rope. As soon as the rope is released from strain, the clips open readily for its free escape as it leaves the pulley. From experiments made with Grip Pulleys of this construction, which have been patented, it has been ascertained that the gripping power varies with the angle at which the clips are set, and is from 50 to 120 times the strain of the slack rope, or of the rope paying on from the slack side. The shape of that part of the clip which receives the rope is the same as that of the rope, and since there is no

slipping of the rope between the clips, the wear upon it when in use is very slight. By reference to the cut, the operation of the clips will be readily understood.

Patent Grip Pulley.



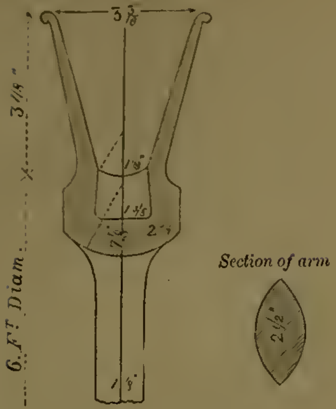
The rope is denoted by *h*; *i*, *i* are clips working on a fulcrum, *xx*. The rope pressing on the clips at the bottom, as it enters them, causes them to close over it, gripping it securely and preventing its slipping. The part of the rim, *k*, is cast

separately, and bolted to the main wheel, *l*, by a bolt. The rim of the wheel is cast with recesses to take the clips, fitting to them and allowing them to work freely; while the clips cannot possibly be displaced, except by removing the part, *k*, which is cast separate for this purpose. From this it will be readily understood that the rope is grasped as soon as the pressure begins to act on the clips, and is released as soon as the pressure is removed, the whole acting automatically and invariably. For *conveying power* over long distances, this feature is of the greatest value. In this system the rope is made of strength sufficient for the transmission, and moves at a velocity of from 300 to 800 feet per minute.

With the high speed system the rope is of smaller size, and travels at a velocity of from 1,500 to 6,000 feet per minute. In order to prevent the too rapid wear of the rope, the high speed pulleys are made with gutta percha seating for the rope. A dovetailed groove is made in the rim of the pulley, into which the gutta percha is forced in the shape of small blocks, dovetailing on the sides, and having a score on the top. When the groove is filled with these blocks, they present a firm and elastic seat for the rope, giving the greatest adhesion possible under the circumstances.

By referring to accompanying cut, the mode of constructing the high speed wheel will be understood; a much smaller rope is required, the proportion being as the velocity.

Section of rim.



In many places in France and Germany, vast amounts of power are transmitted. At Shaffhausen, Switzerland, the water-fall is economized through an overshot water-wheel, and by means of Wire Rope, 600-horse-power are transmitted for a distance of one mile, and thence distributed by means of other smaller Wire Ropes to various factories. The whole Pacific Coast is full of water-powers, and a knowledge of this mode of transmission of power will make many of these water privileges available.

A table of dimensions and velocities has been inserted, which will be found convenient for reference in ascertaining the size and speed of ropes and pulleys, to transmit any given power, either by high speed and smooth pulleys, or by low speed, and the patent grip pulleys.

Transmission Pulleys.

TABLE OF DIMENSIONS AND VELOCITIES.

Horses Power....	HIGH SPEED. Circumference of Ropes. Steel.	HIGH SPEED. Circumference of Ropes. Iron.	HIGH SPEED. Speed of Ropes in feet per minute.	HIGH SPEED. Diameter of wheel.	HIGH SPEED. Revolutions of wheel.........	LOW SPEED. Circumference of Ropes. Steel.	LOW SPEED. Circumference of Ropes. Iron.	LOW SPEED. Speed of Ropes in feet per minute.	LOW SPEED. Diameter of wheel.	LOW SPEED. Revolutions of wheel.........
2	¾ in	1 in	1000	4	80	1 in	1½ in	400	4	32
3	⅞ in	1⅛ in	1000	4	80	1 in	1½ in	600	4	48
4	⅞ in	1⅛ in	1250	4	100	1¼ in	1⅝ in	400	4	32
5	⅞ in	1⅛ in	1500	4	120	1¼ in	1⅝ in	500	4	40
6	⅞ in	1⅛ in	1750	4	140	1¼ in	1⅝ in	600	4	48
8	1 in	1⅜ in	1570	5	100	1½ in	2 in	509	6	27
10	1 in	1⅜ in	1880	5	120	1⅝ in	2⅛ in	603	6	32
15	1⅛ in	1½ in	2260	6	120	1⅞ in	2¼ in	416	6	22
20	1⅛ in	1½ in	2420	7	110	2 in	2½ in	506	7	23
25	1¼ in	1½ in	2640	7	120	2⅛ in	2¾ in	502	8	20
30	1⅜ in	1⅝ in	2750	8	110	2⅛ in	2¾ in	603	8	24
40	1½ in	2 in	2260	9	80	2¼ in	2⅞ in	424	9	15
50	1½ in	2 in	2820	9	100	2¼ in	3 in	509	9	18
60	1½ in	2 in	3400	9	120	2⅜ in	3¼ in	502	10	16
80	1⅝ in	2⅛ in	3800	10	120	2⅜ in	3¼	597	10	19
100	1¾ in	2⅜ in	3200	12	85	2½ in	3½ in	603	12	16
120	1¾ in	2⅜ in	3260	13	80	3 in	3¾ in	603	12	16
150	1¾ in	2½ in	3620	14	80	3¼ in	4 in	616	14	14
200	1¾ in	2½ in	5280	14	120	3⅞ in	5 in	704	14	16
250	2⅛ in	2¾ in	4710	15	100	4 in	5½ in	704	16	14
300	2⅛ in	2¾ in	5650	15	120	4¼ in	6 in	704	16	14

TRANSPORTATION OF MATERIAL OVER MOUNTAINOUS OR OTHER PLACES BY THE PATENT ENDLESS WIRE ROPE-WAY OR WIRE TRAMWAY.

By this system, immense amounts of material can be conveyed over the most mountainous and rugged country, under all climatic difficulties, and at very little cost.

This mode of transporting ores, etc., from the mine to the mill or furnaces, has been introduced in many places with great success. By referring to the cut a general idea is given of the arrangement, but it may be described as follows: At certain distances, say from one hundred and fifty to three hundred feet between the mine and the mill, are erected substantial posts, each post having a cross arm at the top, to the extremities of which are attached two sheaves, a lower and upper, placed one immediately over the other, and which revolve freely on a horizontal spindle. The groove of the lower sheave is made exactly to fit to half the circumference of a wire rope which runs in it, and the groove of the upper covers one-fourth the circumference of the same rope so that it is impossible for it to leave its place. At the mine, and also at the mill, or reducing works, these points being the extremities of the line, a grip pulley is placed horizontally. Around these pulleys, and along the entire line, supported and kept in position by the sheaves attached to the posts, there is stretched an Endless Steel Wire Rope. On this, at distances of about 50 to 150 feet, are firmly attached receptacles for conveying and transporting ores, goods, etc., which in virtue of a peculiar arrangement, pass freely alongside and by various obstacles in the way of posts, sheaves, etc., up hill and down, around corners and over gorges, until they reach the mill, where they discharge their contents by a self-dumping or other

contrivance. The descending boxes, fixed on a rope, which is a double or endless one, carry themselves down by their own weight where there is sufficient descent, and the part of the rope to which they are attached with them; while the other portion of the rope with the empty boxes is carried back to the mine. Usually there is no separation of the receptacles containing the ore from the Wire Rope at any time during its transit, and they pass the various sheaves and pulleys without interruption. The function of the grip pulleys is to hold the rope, so as to prevent its slipping in the groove. Sometimes, the difference in altitude between the mill and the mine is sufficient to obtain by gravitation quite an amount of power, which is transmitted by the grip pulleys for whatever purpose it is required, (and where there is no power obtained in this manner, it is given by a water wheel or steam engine.) The receptacles are small sacks, self-dumping boxes, or other arrangement, which contain from 50 to 300 pounds of ore or other material, and the manner of attachment to the rope is exceedingly simple and effective. One can readily see the great many advantages that this method possesses, from the fact that it requires neither road to be built nor expensive machinery; that it can be run at all seasons of the year, when there is a great depth of snow on the ground; that it can be rapidly and cheaply constructed in the worst possible country; and that when there is sufficient grade, not only does it run itself by gravitation, but produces a motive power at both ends of the line. Running at 200 feet per minute, the boxes are carried down one side of the posts and up the other, 240 per hour, each delivering 100 pounds of ore, or 12 tons per hour, and they can be run 24 hours per day. The total cost of laying down this endless way is from $6,000 to $12,000 per mile, and the cost of carrying the ore about 12 cents per ton per mile.

Application—Advantages.

The foregoing system is *applicable* for the following purposes:

For conveying ores from the mine to the mill.

For conveying light loads of any material from place to place.

For trausporting lumber across difficnlt points, aud to shipping in an offing.

For conveying passengers across gorges, chasms, and over hazardous roads.

For supplyiug water to reservoirs across chasms, etc.

The *advantages* claimed are:

No grading or road buildiug is required.

It can work under all circumstauces of weather, with great depths of snow on the ground, during heavy storms and freshets.

It can run coustantly without rest; as well during a dark night as a clear day.

It can cross deep gorges and chasms.

It can pass around precipitous bluffs and perpendicular cliffs.

The rope can never leave the posts or sheaves.

It can furnish and transmit power, wheu there is sufficient descent, by its own gravitation, or by an engine attached to either end.

It cau be constructed and worked cheaper than any other system or road can be constructed and worked.

By using the duplex carrier it can convey any material, such as lumber, goods, ores, and even passengers, from place to place.

[From the Scientific Press, Feb. 18, 1871.]

We illustrate to-day an invention, recently patented by Mr. A. S. Hallidie, of this city, for the rapid and economical transportation of such material as ores, lumber or goods, over a rough and otherwise inaccessible country, as well as for the transmission of power from one point to another. The invention is one of very considerable merit, and as it concerns a matter of the greatest importance to miners and many others on our coast, we describe it fully.

The invention consists in the use of endless Iron or Steel Wire Ropes, supported on peculiar sheaves, placed on posts, actuated by the gravity of the descending loads, or by an engine attached to a grip pulley, and carrying burdens in the manner hereafter described. Similar inventions have been made before, and the merit of this, therefore, depends on the peculiar construction and adaptation to the wants of the localities.

By reference to the various diagrams appended, this system of Mr. Hallidie's will be fully understood.

Fig. 1 shows a section of a rough mining region, with the undulations and depressions incidental to such a country, over which it is desired to transport ore from the mine, A, to the mill, B, distant, say one mile or more. At proper points, from 200 to 600 (usually 250) feet apart, are erected posts, *c*, with guide-sheaves, on which the rope travels. For the sake of illustration, sacks, *o*, are shown, in the cut, suspended by proper devices to the rope. Near A and B, at each end of the rope-way, are placed horizontal grip pulleys, devised by Mr. Hallidie, 8 to 12 feet in diameter, around and in the groove of which runs an endless Wire Rope of sufficient length to extend from one pulley to the other and back, so that the full sacks, or cars, can be run down on one side and back empty on the other.

Fig. 2 shows the construction of the supporting posts. These are set firmly in the ground, and have on top a cross-beam, on each extremity of which are placed grooved sheaves, *a*, *b*, freely revolving on spindles attached to the cross-arm, and so arranged, one over the other, that the rope will run

Fig. 1.

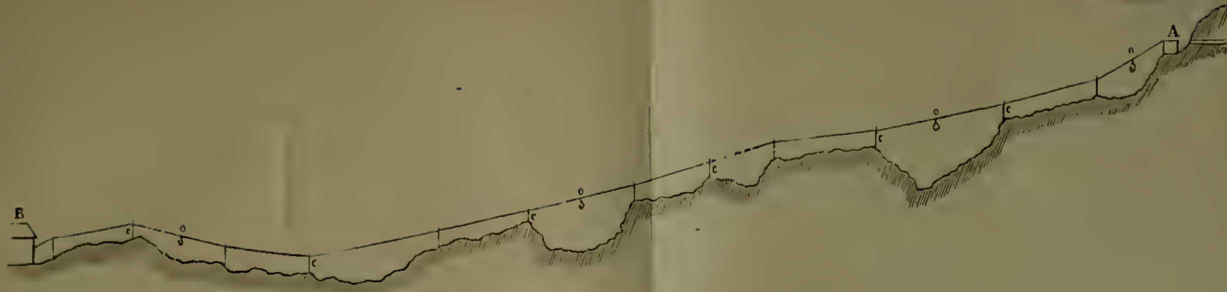


Fig 2.

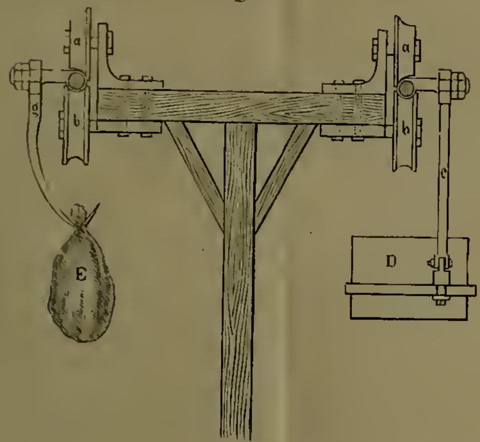


Fig. 3.

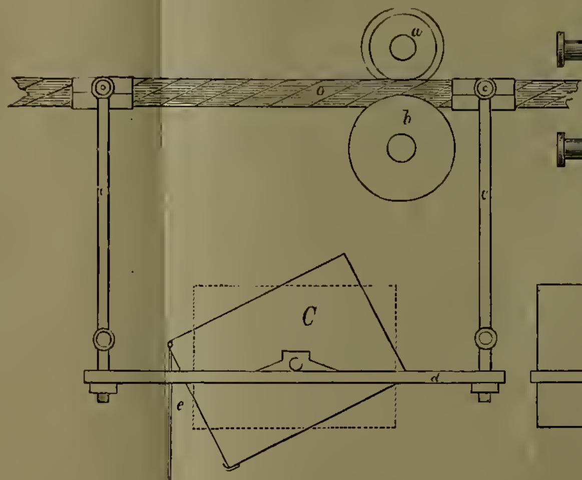
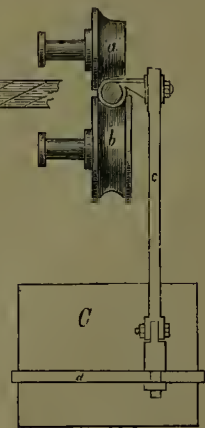


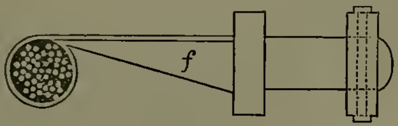
Fig. 4.



between them. The lower sheave, *b*, supports the rope, and the upper one, *a*, keeps it from jumping out of place. In order to give a clear idea, a car, D, is shown on one side, and a sack, E, on the other.

Attached to the Wire Rope at equal distances apart, usually about every 50 feet, are peculiarly constructed carriers. Figs. 3 and 4 show these and the manner of attaching them to the Wire Rope; Fig. 3 giving a side view and Fig. 4 an end view. Here, *a* and *b* are the sheaves, o the rope, and C, the car. The carrier supports a frame *d*, which is hung on standards, *c*, in such a manner that the carriers will always maintain a horizontal position, whether going up hill or down. The standards, c, are attached to the carrier, *f*, shown on a larger scale in Fig. 5. The end of the bar is swaged out into a band which

Fig. 5.



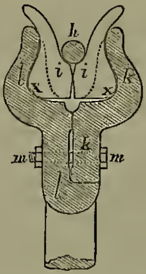
encircles the Wire Rope and is riveted to the bar, so as to hold the rope sufficiently to prevent slipping. The carrier, *f*, is about one-half the thickness of the rope, and as the center of gravity of the load comes vertically below the Wire Rope, this carrier always stands out horizontal, and thus allows the load to be carried past the sheaves and pulleys without interference. One end of the car is an apron, *e*, which enables the load to dump itself as it passes between guides at the point of delivery.

Instead of such a car, sacks may be used if preferred. The simpler arrangement for attaching the sacks, essentially the same as in the case of the car, is shown at *g*, Fig. 2.

Fig. 6.

Fig. 6 shows the patent grip pulley employed at each end of the line, and which is placed horizontally; Fig. 7 is a section of the rim of the pulley, showing the mode of construction. The rope is denoted by *h; i, i* are clips working on a fulcrum, *x, x*. The rope pressing on the clips at the bottom, as it enters them, causes them to close over it, gripping it securely and preventing its slipping. The part of the rim *k*, is cast separately, and bolted to the main wheel, *l*, by the bolt, *m, m*. The rim of the wheel is cast with recesses to take the

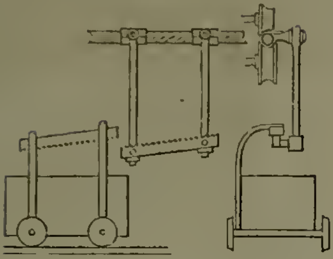
Fig. 7.



clips, fitting them and allowing them to work freely; while the clips cannot possibly be displaced, except by removing the part, *k*, which is cast separate for this purpose.

From this it will be readily understood that the rope is grasped as soon as the pressure begins to act on the clips, and is released as soon as the pressure is removed, the whole acting automatically and invariably. For *conveying power* over long distances, this feature is of the greatest value.

Fig. 8.



A car is shown in Fig. 8, which may be found very useful in certain cases, as it economizes in manual labor. A car is mounted on wheels so that it can be run into the mine. It has a carrying frame above it, the longitudinal beam of which is inclined so as to correspond with that of the standards. Both are toothed, the former on its lower, the latter on its upper side. Now if the car be run into position when the standards, which are attached to the rope, come around, they will catch and carry off the car without any manual labor. The teeth on the beams prevent any slipping.

The general system and manner of working of the rope-way will now be understood by a glance at Fig. 1. By it, material can be transported from a higher to a lower, or from a lower to a higher point. In the last case, power must be applied, which can be done directly from a stationary engine at one end by means of the grip pulley; in the first case, often no extra power will be needed, the gravity of the descending loads being sufficient to keep the rope in motion.

In erecting this system, after the route has been decided on, posts are placed on the prominent points, being of a sufficient height that the rope may be clear from all obstructions on the ground—as snow, rocks, cattle, etc. At suitable distances between these (which serve to fix the principal points of the line), say 200 feet apart, other posts are erected to sup-

port and lead the traveling Wire Rope. The height and number of these are regulated by the configuration of the line and the neccssities for sustaining the rope.

The posts being in position aud the grip pulleys being in working order, the coil of Wire Rope is placed at the upper terminus of the line, and one end is put in the grip pulley and carried along from one post to another, being placed between the sheaves on the posts. A brake attached to the grip pulley regulates the paying out of the rope. One coil being exhausted, the end of the next one is joined to it by a long splice, and the operation is continued until the rope has been carried down one side. Another Wire Rope is then, iu a similar manuer, brought down the other side, and the two ends are spliced, the Wire Rope being placed in the groove of the upper pulley. By means of a powerful purchase at thc lower end the rope is stretched tight, spliced aud put in the lower pulley.

At the lower end, provision is made by a suitable frame and apparatus, for taking up the slack which occurs for some days after the rope is put on, and then disappears. The carriers are then attached and the liue is ready for work.

READ THE FOLLOWING:

EUREKA, NEVADA, July 10th, 1872.

T. M. MARTIN—MY DEAR SIR: On your leaving for San Francisco, it gives me grcat pleasure to hand you my written acceptance of the HALLIDIE TRAMWAY put up by you upon our mine in Freiburg.

It is a perfect success, discharging ten tous of ore per hour with two men's labor. It is perfectly simple in construction, and, as far as I cau judge, there is nothing about it to ever get out of order—nothiug to wear out. While ours requires but about two thousand five hundred feet of Wire Rope, I can see no reason why thc line could not be extended almost indefinitely with equally happy results. Again, the carrying

capacity might be doubled or quadrupled if desired. After several weeks trial upon our mine, the unanimous verdict of all who have seen it is a complete, unquestioned success. If this can be of any service to you, use it in any way you think proper.

Very respectfully,
C. C. GOODWIN.

EMMA HILL CONSOLIDATED MINING CO.,
LITTLE COTTONWOOD, UTAH,
SUPERINTENDENT'S OFFICE, Sept. 28th, 1872.

T. M. MARTIN, ESQ.—SIR: The Ropeway constructed by you (*Hallidie's Patent*), for the Emma Hill Consolidated Mining Company, has been built in a most substantial and workmanlike manner, and is at this time in splendid working condition. I most cheerfully accept the work for the Company, and recommend it to others wishing a sure and speedy transit for ores over places impracticable for wagon roads, etc.

Respectfully,
L. U. COLBATH, Superintendent.

The Vallejo Ropeway.

The Vallejo Tunnel Company's Tramway in Little Cottonwood, built on the *Hallidie Patented Plan*, is a complete success. It is between 2,300 and 2,400 feet in length, and is supported by thirteen stations. The fall in this distance is about 600 feet, and the Wire Rope, which is three-fourths of an inch in diameter, will safely and easily deliver one hundred tons in six hours. The machinery is automatic, loading and unloading the sacks or buckets. The stations are about two hundred feet apart, and the entire apparatus is strong and safe. As the Wire Rope is elevated about forty feet above the surface of the hill, the Tramway can be worked all winter long, without the slightest trouble.—*Utah Mining Journal*, Salt Lake, Sept. 23d, 1872.

Patent Grip Pulleys.

These pulleys are made expressly for the purpose of transmitting power by means of Steel or Iron Wire Ropes.

By referring to the diagrams on pages 25 and 36, figs. 6 and 7, and the description on same pages, their mode of action can be readily understood.

By means of these Grip Pulleys it is possible to transmit power from one point to another, and to the limit of the strength of the rope employed.

It will thus be seen that this arrangement is adapted for conveying power from a waterfall in a river, or where there is a large stationary engine, to any point desired, one, three or five miles distant, the Wire Rope being supported on sheaves at intervals in order to keep the rope off the ground, and lead it in the proper direction.

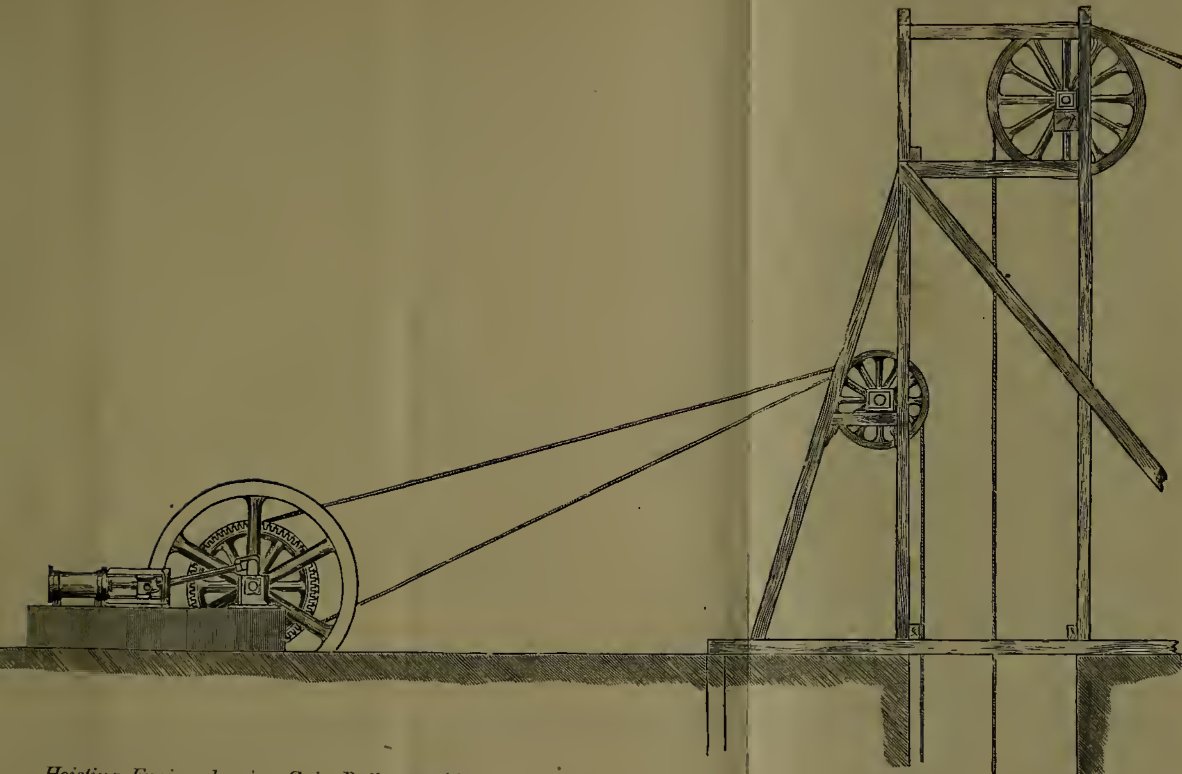
As a means of transmitting power from a portable steam engine to a thrashing machine it enables the farmer to keep his steam engine sufficiently far from the grain to avoid conflagration.

It is the most economical and convenient mode of transmitting power, and is available for innumerable cases, and any locality, as the rope *cannot slip* in the groove, and the pulley does not wear the rope, as a concave drum, capstan, or figure of 8 pulley does.

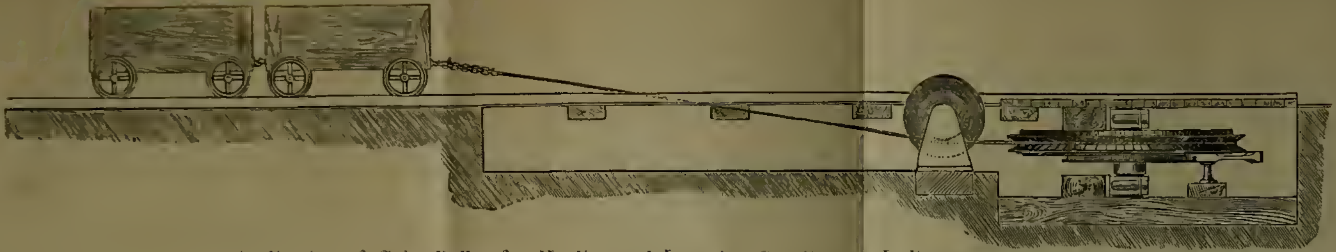
For hoisting works in a mine where a car is attached to both ends of the rope, for an inclined, vertical or horizontal shaft, it is admirably adapted, economizing in machinery and wear of rope.

For steam plowing by means of ropes it works to great advantage, being much simpler in its action than any other form of pulley.

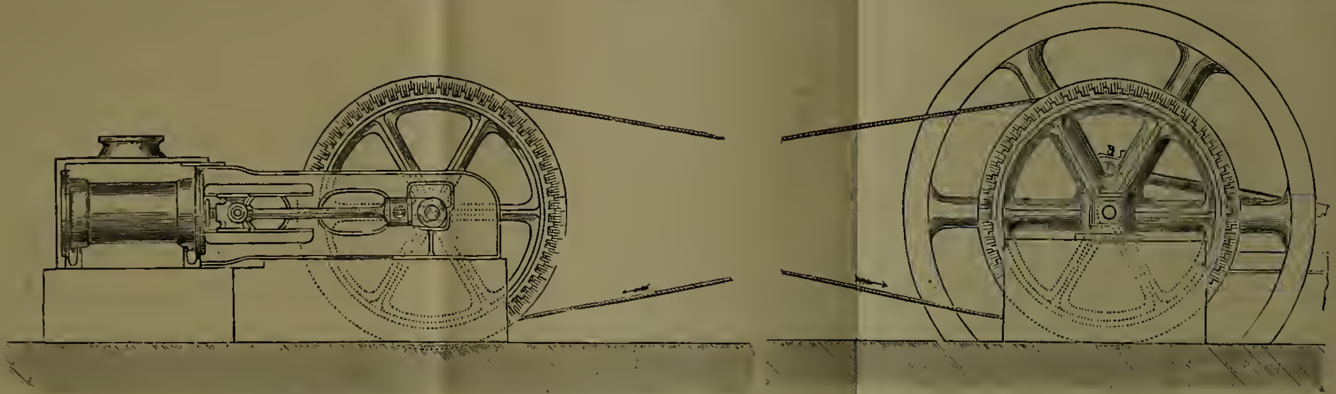
These pulleys are made all sizes, but the size of the grip pulley should not be less than 100 times the size of the rope.



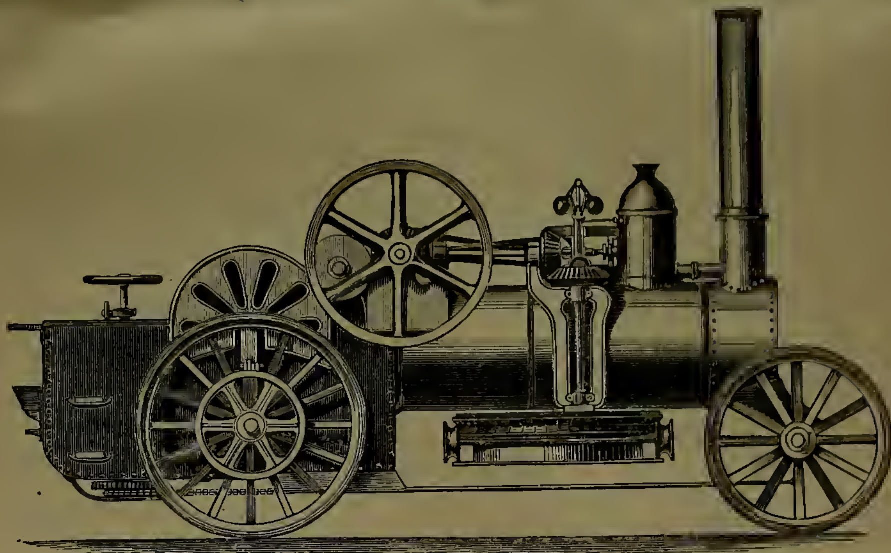
Hoisting Engine showing Grip Pulley working hoisting rope in vertical shaft, or transmitting power to lower levels.



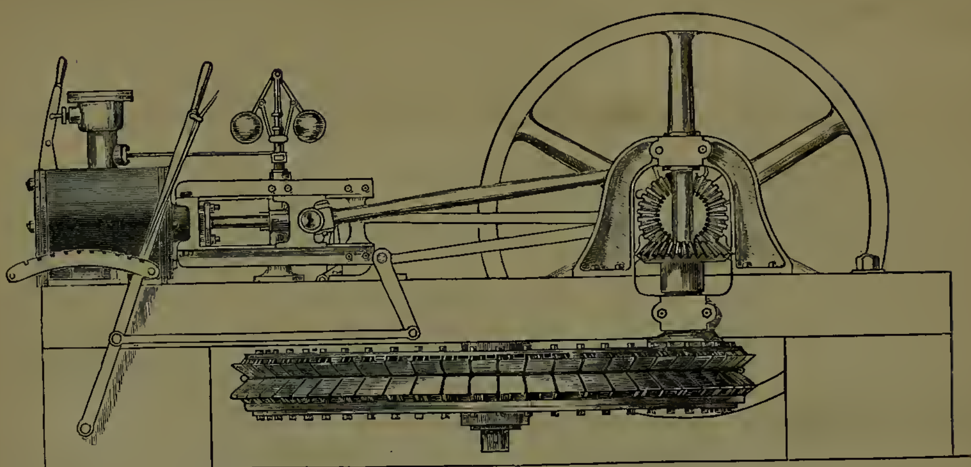
Application of Grip Pulley for Hauling and Lowering Ore Cars on Inclines.



Application of Grip Pulleys for Transmitting Power.



Portable Steam Engine with Grip Pulley, for Transmitting Power, Steam Plowing, etc.



Stationary Steam Engine with Horizontal Grip Pulley attached.

To Ascertain Velocity of Water in a Brook.

RULE.—Take the number of inches that a floating body passes over in one second in the middle of the current, and extract its square root; double this root, subtract it from the velocity at top, and add 1; the result will be the velocity of tho stream at the bottom—and the mean velocity of the stream is equal to the velocity of the surface, less the square root of the velocity at the surface +.5.

Example. If the velocity at the surface and middle of a stream be 36 inches per second, what is the mean velocity?

Square root of 36=6×2=12 to bo subtracted from 36=24, add 1=25 inches per second, velocity at bottom. Then 36 less 6=30 add .5=30.5 inches, answer, mean velocity.

To Find the Quantity of Water which will Flow Out of an Opening.

RULE.—Multiply the square root of the depth of the water by 5.4; the product is the velocity in feet per second: this multiplied by the area of the opening in feet will give the number of cubic feet per second.

Example. If the centre of an opening is 10 feet below the surface of the water, and its area is 2 feet, what quantity of water will run out in one minute?

$\sqrt{10}=3.16\times5.4\times2=34.1496$ feet =(34 1-7 feet.)

Water will fall through 1 foot in ¼ second, 4 feet in ½ second, 9 feet in ¾ second, and so on—being actuated by the same laws as falling bodies.

On the Size of Pulleys, Drums, etc.

We cannot too strongly call the attention of the mechanic and miner to the general errors committed in proportioning the Pulley, Drum, or Whirls, of hoisting or driving gear. We would remind them that when a pulley is under a certain diameter for certain sized ropes, be the rope of Hemp or Wire, it will very soon destroy the fibres by the constant chafing and wearing of the internal portion of the rope, long before it has had a chance to test its strength or durability. An examination of any rope after running for some time on a pulley of a small diameter, will fully and clearly demonstrate the fact to the examiner, moreover, as it requires some exertion to bend a rope around a small circle, an unprofitable expenditure of power is required, and besides there is a loss of frictional surface, and this is a serious matter in driving heavy machinery when the grip pulley is not employed; therefore, it is very essential that the diameter of the drum or pulley should be attended to, and for the guidance of those erecting such machinery, we offer them the following general rule:

Rule.—For Wire Rope, the pulley or drum should be 100 times the size of the rope. For Hemp Rope, the pulley should be 50 times the size of the rope. For Flat Iron Rope, the diameter of same should be not less than 150 times the thickness of the rope.

It will be seen that the same size pulleys answer for both Wire and Hemp Rope *of the same strength.*

[See Table of Comparative Strength of Ropes.]


LOOMIS.F.S.
ERECTED BY A.S. HALLIDIE & CO. S.F.

Wire Suspension Bridges and Flumes.

Having been engaged for fourteen years in building Wire Suspension Bridges and Flumes, I am prepared to do such work in a thorough and economical manner.

I have built and erected Bridges and Flumes in almost every portion of the State, of spans varying from 200 to 400 feet; all of which have been constructed to the owners' satisfaction, and to whom I take pleasure in referring those who are about to build.

My facilities for erecting these bridges are unequalled. All the wire employed by me is drawn for that purpose expressly, and to parties about to build I would say that I can erect their whole work in a thorough manner; or, I will furnish plans and specifications of their bridges and all wire and iron work, at a low and satisfactory figure.

An examination made by a competent engineer and definite estimates of the cost of all or any portion given if desired, upon payment of expenses.

Blasting.

In small blasts 1 ℔ powder will loosen 4½ tons.

In large blasts 1 ℔ powder will loosen 2¾ tons.

One man can bore with a bit 1 inch diameter from 50 to 100 inches per day of 18 hours, in granite, or 300 to 400 inches per day in limestone.

Two strikers and a holder can bore with a 2 inch bit 10 ft. per day in rock of medium hardness.

At the depth of 45 feet the temperature of the earth is uniform throughout the year.

Velocity of Water in Pipes and Sewers.

Table of the heads of water necessary to maintain different velocities of water in 100 feet of pipe.

V represents the velocities in feet per minute, and *C* the constant number for those velocities.

V	*C*	*V*	*C*	*V*	*C*
60	8.62	90	17.95	140	38.90
70	11.40	100	21.56	150	44.
80	14.58	120	29 70	180	62.13

Table of the constant number for different velocities.

D represents diameter of pipe, in inches, and c the constant number for their diameters.

D	c	*D*	c	*D*	c
4	.028	6	.078	8	.134
5	.053	7	.104		

RULE. Then when H represents the head of water $\frac{c}{D \times C} = H$.

Example. It is required to determine what head of water would be necessary to send water through 1500 feet of six-inch pipe, to an elevation of 80 feet, and at a velocity of 180 feet per minute.

C.=62.13÷ (6+c.078) 6.078=10.22 in. which ×15 (the number of 100 feet) =153.3 in. (12 ft. 9 in.) this added to 80 gives 92 ft. 9⅓ in., answer.

The time occnpied in an eqnal qnantity of water through a pipe or sewer of equal length and with eqnal falls, is proportionately as follows: In a right line, as 90, in a true curve, as 100, and in a right angle as 140.

Overshot Water-Wheel.

RULE TO ASCERTAIN POWER.—Multiply the weight of water, in lbs., discharged upon the wheel in one minute, by the height or distance, in feet, from the lower edge of the wheel to the centre of the opening in the gate; divide the product by 50,000, and the quotient is the number of horses' power.

Example. Suppose the weight of water discharged per minute is 39,000 lbs. If the height of the fall is 23 feet, the diameter of the wheel 22, what is the power of the wheel?

22 feet less 8 inches clearance below=22′ 4″=22.33. 39,000 ×22.33=870,870÷50,000=17.41 horse-power.

RULE TO ASCERTAIN VELOCITY OF WATER AND WEIGHT PER MINUTE, IN POUNDS, DISCHARGED ON OVERSHOT WATER-WHEEL.—Extract square of height of head of water (from surface to middle of gate) and multiply by 8 if the opening is large and head small; if the reverse, multiply by 5.5; or, from 8 to 5.5 in proportion to size of opening and head of water.

Example. The dimensions of the stream are 2 by 80 inches, with a head of 2 feet to upper surface of water. What is the velocity of the water per minute?

2 feet plus half of 2 inc.=25 inc. =2.08, the square of which is 1.44×6.5 (estimate of velocity)=9.36×60=561.60 feet.

What is its weight?

Example. 80 inches ×2×6739.20 inches (=561.60 feet)= 1,078,272÷1728 (inches in a cubic foot)=624 cubic feet×62½ lbs. (weight of cubic foot of water)=39,000 lbs. weight discharged in one minute.

Length of Cut Nails and number in one lb.

	3	4	5	6	8	10	12	20	30	40
Length...............	1¼	1½	1¾	2	2½	3	3¼	3½	4	4¼
No. in lb.............	420	270	220	175	100	65	52	28	24	20

Weight of Bar Iron.

Square, from 3/8 to 2 1/2 inch, and 1 foot long.

Size in inches.	Wg't in lbs.	Size in inches.	Wg't in lbs.	Size in inches.	Wg't in lbs.	Size in inches.	Wg't in lbs.
3/8	.475	7/8	2.588	1 3/8	6.390	1 7/8	11.880
1/2	.845	1	3.380	1 1/2	7.604	2	13.520
5/8	1.320	1 1/8	4.278	1 5/8	8.926	2 1/4	17.112
3/4	1.901	1 1/4	5.280	1 3/4	10.352	2 1/2	21.120

Round Bar from 3/8 to 2 1/2 inches diameter and 1 foot long.

Diam'r	W't in lbs.	Diam'r	W't in lbs.	Diam'r	W't in lbs.	Diam'r	W't in lbs.
3/8	.373	7/8	2.032	1 3/8	5.019	1 7/8	9.333
1/2	.666	1	2.654	1 1/2	5.972	2	10.616
5/8	1.043	1 1/8	3.360	1 5/8	7.010	2 1/4	13.440
3/4	1.493	1 1/4	4.172	1 3/4	8.128	2 1/2	16.680

Flat Bar from 3/4x1/8 to 5x1 and 1 foot long.

Size in inches,	Wg't in lbs,	Size in inches,	Wg't in lbs,	Size in inches,	Wg't in lbs,	Size in inches,	Wg't in lbs,
3/4x1/8	0.316	1 3/4x1/4	1.479	2 1/2x1/4	2.112	3x1	10.138
3/4x1/4	0.633	3/8	2.218	3/8	3.168	3 1/2x1/4	2.957
3/4x3/8	0.950	1/2	2.957	1/2	4.224	3/8	4.436
7/8x1/8	0.369	5/8	3.696	5/8	6.280	1/2	5.914
x1/4	0.738	2x1/4	1.689	3/4	6.336	5/8	7.393
1x1/8	0.422	3/8	2.534	2 3/4x1/4	2.323	3/4	8.871
x1/4	0.845	1/2	3.379	3/8	3.485	1	11.828
x3/8	1.267	5/8	4.224	1/2	4.647	4x1/4	3.380
1 1/4x1/8	0.528	3/4	5.069	5/8	6.808	1/2	6.759
1/4	1.056	2 1/4x1/4	1.900	3/4	6.970	3/4	10.138
3/8	1.584	3/8	2.851	3x1/4	2.535	1	13.518
1 1/2x1/8	0.633	1/2	3.802	3/8	2.802	5x1/4	4.224
1/4	1.266	5/8	4.750	1/2	5.069	1/2	8.449
3/8	1.900	3/4	6.703	5/8	6.337	3/4	12.673
1/2	2.535	2 1/2x1/4	2.112	3/4	7.604	1	16.897

To convert into weight of other metals, multiply the above for Cast Iron by .93; for Steel $\times$ 1.01; for Copper $\times$ 1.15; for Brass $\times$ 1.09; for Lead $\times$ 1.48; for Zinc $\times$ .92.

Weight of a Superficial Foot of Plates, Different Metals, in Pounds.

Thick. Inches.	Iron.	Brass.	Copper.	Lead.	Zinc.	Thickness. Inches.
1-10	2.5	2.7	2.9	3.7	2.3	.0625=16 B. W. G.
1/8	5.0	5.5	5.8	7.4	4.7	.125 =11 "
3-16	7.5	8.2	8.7	11.1	7.0	.1875= 7 "
1/4	10.0	11.0	11.6	14.8	9.4	.25 = 4 "
5-16	12.5	13.7	14.5	18.5	11.7	.3125= 1 "
3/8	15.0	16.4	17.2	22.2	14.0	.375
7-16	17.5	19.2	20 0	25.9	16.4	.4375
1/2	20.0	21.9	22.9	29.5	18.7	.5
9-10	22.5	24.6	25.7	33.2	21.1	.5625
5/8	25.0	27.4	28.6	36.9	23.4	.625
11-16	27.5	30.1	31.4	40.6	25.7	.6875
3/4	30 0	32.9	34.3	44.3	28.1	.75
13-16	32.6	35.6	37.2	48.0	30.4	.8125
7/8	35.0	38.3	40.0	51.7	32.8	.875
15-16	37.5	41.2	42.9	55.4	35.1	.9375
1	40.0	43.9	45.8	59.1	37.5	1.0000

Melting Points of Alloys.

Lead 2, tin 3, bismuth 5........................312°
Lead 1, tin 3, bismuth 5........................210
Lead 1, tin 4, bismuth 5........................240
Tin 1, bismuth 1................................286
Tin 2, bismuth 1................................336
Lead 2, tin 3...................................334
Tin 8, bismuth 1................................392
Lead 2, tin 1, (solder).........................475
Lead 1, tin 2 (soft solder).....................360
Zinc 1, tin 1...................................399
Lead 1, tin 1...................................368
Lead 1, tin 1, bismuth 4, cadmium 1.............155

75 parts of lead, 16 7-10ths parts of antimony, 8 3-10ths parts bismnth, forms a metallic alloy that expands in cooling.

Size, Weight, Length and Strength of Iron Wire.

Wire Gauge.	Diameter.	Weight of 100 Feet.	Weight of one Mile.	Length of one Bundle, sixty-three lbs.	Length of 100 lbs.	Breaking Strain.	Wire Gauge.
No.	Inches.	Lbs.	Lbs.	Feet.	Feet.	Lbs.	No.
00	0.363	34.00	1719	186	295	8290	00
0	0.331	28.24	1490	222	353	6880	0
1	0.300	22.92	1210	273	434	6650	1
2	0.280	19.97	1054	315	609	4930	2
3	0.260	17.22	909	363	576	4250	3
4	0.240	14.67	775	429	683	3620	4
5	0.220	12.33	651	510	810	3040	6
6	0.200	10.19	638	609	967	2510	6.
7	0.185	8.72	461	717	1147	2220	7
8	0.170	7.37	389	858	1313	1840	8
9	0.155	6.12	323	1026	1631	1660	9
10	0.140	4.99	264	1260	2000	1280	10
11	0.125	3.98	211	1587	2515	1000	11
12	0.110	2.08	163	2100	3333	800	12
13	0.095	2.35	124	2679	4069	668	13
14	0.085	1.84	97	3426	5440	456	14
15	0.075	1.43	76	4404	6986	452	15
16	0.066	1.07	67	6862	9303	264	16
17	0.057	0.83	44	7620	12094	208	17
18	0.050	0.64	34	9450	15000	160	18
19	0.045	0.52	27	12255	19409	128	19
20	0.040	0.41	21	14736	24557	104	20
21	0.035	0.31	17	19248	32089	80	21
22	0.030	0.23	12	26208	43660	66	22

Sizes Wire expressed in Fractions of an Inch.

No.	000	full,	3/8	inch.	No.	3	full,	1/4	inch.
"	00	"	11–32	"	"	6	"	3–16	"
"	0	"	5–16	"	"	8	"	5–32	"
"	1	"	9–32	"	"	11	"	1/8	"

The tensile strength of the best tempered Steel Wire is fully double the above.

Annealing Wire reduces its tensile strength about 40 per cent.

MISCELLANEOUS ITEMS.

A Pipe of Cast Iron, 15 inches diameter, ¾ inch thick, will sustain a head of water of 600 feet. One of Oak, 2 inches thick, same diameter, will sustain a head of 180 feet.

When the cohesion is the same, thickness varies as the height multiplies by the diameter.

In sandy soil, the greatest force of a pile-driver will not drive a pile over 15 feet.

Table of the Value of an Ounce of Gold, of different degrees of fineness.

Fineness.	$ cts.	Fineness.	$ cts.	Fineness.	$ cts.	Fineness.	$ cts.
750	15 60	875	13 08	894	18 48	909	18 79
760	15 71	880	18 19	895	18 50	910	18 81
770	15 91	881	18 21	896	18 52	911	18 83
780	16 12	882	18 23	897	18 54	912	18 85
790	16 33	883	18 25	898	18 56	913	18 87
800	16 53	884	18 27	899	18 58	914	18 89
810	16 74	885	18 29	900	18 60	915	18 91
820	16 95	886	18 31	901	18 62	916	18 93
830	17 15	837	18 33	902	18 64	917	18 95
840	17 36	888	18 35	903	18 66	918	18 97
850	17 67	889	18 37	904	18 68	919	18 99
855	17 67	890	18 39	906	18 70	920	19 01
860	17 77	891	18 41	906	13 72	930	19 22
865	17 88	892	18 43	907	18 74	940	19 43
870	17 98	893	18 45	908	18 77	950	19 63

A horse-power is equivalent to 33,000 lbs. raised one foot high in one minute.

River Pump.—To construct and use a chain pump to the best advantage, the distance between the buckets should be equal to their breadth; and the pump barrel should have an inclination of 24° 21″. With this arrangement it produces a maximum effect.

Water Required in Working Quartz.

Each stamp uses 10 pounds per minute.

Each pan uses 16 pounds per minute.

Each settler uses 9 pounds per minute.

If the water is run from the mill into settling tanks it can be saved with a loss of 20 per cent. This will make the actual supply of water required in pounds per minute to be as follows:

For

1 Stamp .... 2.
1 Pan.................................... 3.2
1 Settler 1.8

TABULAR SCALE.

Showing approximately the comparative strength, size and weight per 100 ft. in length, of WIRE ROPES, HEMP ROPE and CHAIN. The sizes on each horizontal line being of equal strengths.

CAPACITY OF THE ROPES AND CHAINS.		ROUND IRON WIRE ROPE.		ROUND STEEL WIRE ROPE.		ROUND HEMP ROPE.		FLAT IRON WIRE ROPE.		FLAT STEEL WIRE ROPE.		IRON CHAIN.	
Work'g Load. LBS.	Break'g Stren'th TONS.	Circumference. INCHES.	Weight 100 feet LBS.	Circumference. INCHES.	Weight 100 feet. LBS.	Circumference. INCHES.	Weight 100 feet. LBS.	Size. INCHES.	Weight 100 feet. LBS.	Size. INCHES.	Weight 100 feet. LBS.	Diam. of Link. INCHES.	Wg't 100 ft. LBS.
300	1	1	17	—	—	2¾	33	—	—	—	—	¼	66
550	1½	1¼	23	—	—	3	60	—	—	—	—	6-16	92
800	2½	1½	28	1	17	3¼	55	—	—	—	—	⅜	133
1,500	4½	1¾	43	1½	28	4¼	78	—	—	—	—	7-16	183
2,000	6	2	66	1⅝	36	5	100	—	—	—	—	½	260
2,500	7½	2¼	86	1¾	45	6	150	—	—	—	—	9-16	300
3,300	10	2½	108	2	65	6½	166	—	—	—	—	—	—
4 200	12½	2¾	124	2⅛	75	7	200	2x⅜	132	—	—	⅝	400
6,000	16	3	140	2¼	86	7½	234	2¼x⅜	154	—	—	11-16	460
6,000	18	3¼	158	2⅜	97	7¾	250	2½x⅜	168	—	—	—	—
7,000	21	3½	180	2½	110	8¼	284	3x⅜	220	2x⅜	132	¾	633
8,000	24	3¾	200	3	140	9	333	3x½	270	2½x⅜	168	13-16	650
9,000	27	4	250	3¼	158	10	433	4x⅜	315	2½x½	190	⅞	720
10,000	30	4¼	284	3½	190	10½	466	4x½	366	3x⅜	220	16-16	833
11,000	33	4½	320	3⅝	195	11	600	4½x½	390	—	235	1	933
12,000	36	4¾	350	3¾	200	12.	667	6x½	400	3½x⅜	240	—	—
13,500	40	6	380	3⅞	225	13	784	6½x½	450	3x½	270	1 1-16	1000
18,000	56	6½	440	4	250	14	900	5x½	500	4x⅜	300	—	—
22,000	65	6	640	4¼	280	16	1166	6½x½	560	6x⅜ 4x½	330	—	—

NOTE.—The Winding Drums or Pulleys should be one hundred times the size of the rope, and round ropes should lead fair on to and FIT the groove of the pulleys. We manufacture two kinds of round rope: Flexible Rope of 114 wires; Ordinary Rope of 42 wires.

PRICES.

Iron Wire Strand for Fencing and Signal Cord.

Trade number	5	4	3	2	1
Diameter in inches	⅛	3-16	¼	5-16	⅜
Price per 100 feet, Common	$1 85	2 25	2 65	3 00	3 15
Price per 100 feet, Galvanized	$2 10	2 55	2 85	3 25	3 60

Iron and Copper Wire Cords.

For Window Sashes, Dumb Waiters, Picture Cords, Signal Cords.

Circumference in inches	¼	⅜	½	⅝	¾
Price per yard, Iron	10 c.	14	18	22	25
" " Galvanized Iron	16 c.	20	22	25	35
" " Copper	20 c.	25	30	35	40

Gold and Silver Plated Picture Cord.

Trade number	1	2	3
Circumference in inches	½	⅜	⅛
Price per yard	60 c.	35 c.	20 c.

PRICES OF WIRE ROPES.

ROUND ROPES.	coarse.	flexible.
Hoisting Rope of Iron Wire..............		c. per lb.
Hoisting Rope of Steel Wire..............		c. per lb.
Galvanized Rope for Rigging..............		c. per lb.
FLAT ROPES.		
Iron Wire..............................		c. per lb.
Steel Wire..............................		c. per lb.

BRIGHT AND ANNEALED MARKET IRON WIRE.

Nos..........	0 to 6	7 to 9	10 and 11	12	13 and 14	15 and 16	17	18
Cts. per lb.	9	10	11	11½	12½	14	15	16
							Disct.	

COPPERED MARKET WIRE, same list as above. Disc.

COPPERED PAIL WIRE, " " Disc.

ANNEALED STONE WIRE.

Nos......	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
Cts. per lb.	19	20	21	22	23	24	25	26	28	29	30	32	33	35	37	40
						Disc.							Disc.			

GALVANIZED IRON WIRE.

Nos......	0 to 6	7 to 9	10 and 11	12	13	14	15	16	17
Cts. per lb.	16	17	18	20	22	24	26	28	30
							Disc.		

TINNED WIRE.

Nos......	0 to 9	10 and 11	12 to 14	15and16	17	18 to 20	21and22	22 to 24
Cts. per lb.	15	16	17	17½	18	20	21	22
							Disc.	

Coppered Spring Wire for Mattrass, Sofa and Chair Springs.
STEEL WIRE, TELEGRAPH WIRE, COPPER WIRE,
FENCE WIRE, BRASS WIRE, SOLDER WIRE.
And all kinds of Special Wire made to order.